Transmission Modes

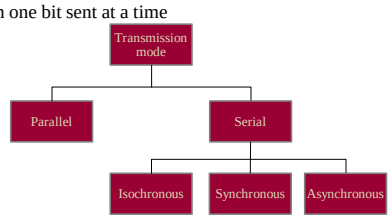
Gail Hopkins

Introduction

- More fundamental concepts underlying data communications!
- Ways data are transmitted
- Parallelism
- Synchronous and asynchronous communication
  - RS-232-C

Transmission Modes

- Two categories
  - Serial
    - One bit sent at a time
  - Parallel
    - More than one bit sent at a time

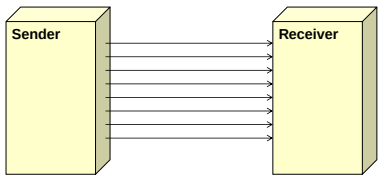


From Comer, 2009

Parallel Transmission

- Multiple data bits transferred at the same time over separate media
- Generally used with wired medium with multiple independent wires
- Signals on all wires are synchronised
  - Each wire carries the signal for one bit
  - All wires operate simultaneously
- Other wires allow sender and receiver to coordinate
- Wires placed in a single large cable

Parallel Transmission



- A bit travels across each of the wires at exactly the same time

From Comer, 2009

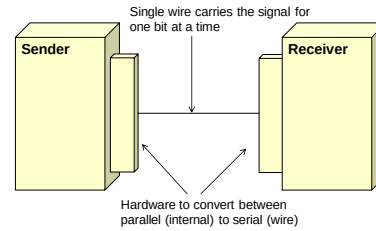
Parallel Transmission - Advantages

- High speed
  - Faster than serial as more wires!
- Match to underlying hardware
  - Computers and communication hardware use parallel circuitry internally

Serial Transmission

- Sends one bit at a time
- Most communications system use serial mode
  - Cheaper to extend over long distances
    - Fewer wires
    - Intermediate electronic components are cheaper
  - Never a timing problem caused by one wire being slightly longer than another
    - Because only one wire!

Serial Transmission

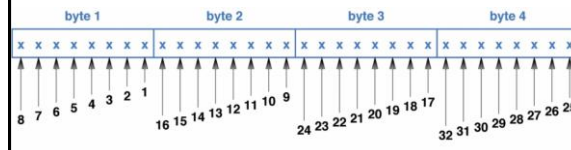


- Sender and receiver need small amount of hardware to convert data from parallel form used in the device to serial form used on the wire

Transmission Order: Bits and Bytes

- Which *bit* should be sent across a medium first?
  - Most Significant Bit (MSB)
    - Big Endian
  - Least Significant Bit (LSB)
    - Little Endian
- Which *byte* should be sent first??
  - Byte order and bit order can be chosen independently

Transmission Order (2)



From Comer, 2009

- Ethernet technology specifies that data is sent *byte big-endian* and *bit little-endian*

Timing of Serial Transmission

- Three broad categories of serial transmission:
  - Asynchronous
    - Transmission can occur at any time
    - Arbitrary delay between the transmission of two data items
  - Synchronous
    - Continuous transmission
    - No gap between transmission of data items
  - Isochronous
    - Transmission occurs at regular intervals
    - Fixed gap between transmission of two data items

Asynchronous Transmission

- Allows physical medium to be idle for an arbitrary amount of time between transmissions
- Good for applications that generate data at random
  - E.g. keyboard connected to a computer
- BUT – lack of coordination between sender and receiver

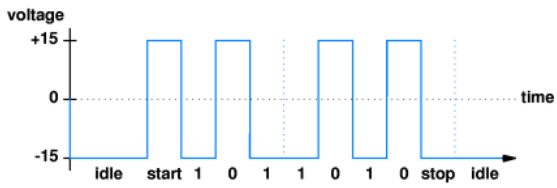
Asynchronous Transmission (2)

- Receiver does not know when the sender will transmit
  - transmit when data are ready
  - variable delays between transmissions
  - no sender-receiver coordination beforehand
- Technically, the electrical signal does not contain information about where individual bits begin and end
  - Therefore common for technologies to specify a preamble
    - Few extra bits before each data item to tell receiver data are coming

Asynchronous Character Transmission - The RS-232 Standard

- To connect keyboards, terminals etc. to computers over copper wire
- Concerned with 7-bit characters
- Details of physical connection (maximum length, plugs and sockets)
- Electrical details (voltages)
- Serial communication
- Asynchronous (for each character)

Example RS-232 Waveform



RS-232

- Never leaves 0 volts on the wire - an idle line is the same as a 1 bit
- Sender and receiver agree how long a bit lasts - receiver uses a local timer
- A 0 start bit signifies the start of a character and is followed by 7 data bits
- A minimum gap of 1 bit between characters (a phantom stop bit of 1)

Baud Rate Revisited

- Transmission hardware is rated in *baud* - the number of signals that are generated per second
- The *baud rate* need not be the same as the *bit rate*, it depends on how many levels of signal are used
- With RS-232 they are the same

Agreeing the Baud Rate

- Sender and receiver agree on length of time each bit is held => maximum number of bits per second (e.g., 300, 9600, 19200)
- RS-232 may often have a configurable baud rate (manually or by software)

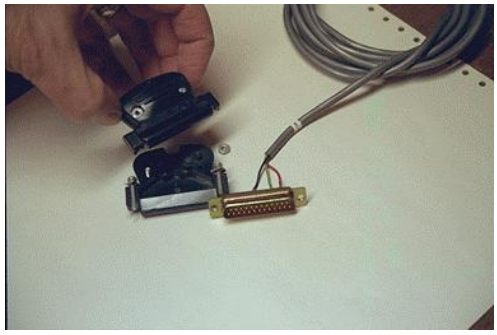
Framing Errors

- Might occur if the sender and receiver are set to different baud rates
- Receiver samples the signal several times for each bit to check for differences (framing errors)
- Used by the break key to send an abort signal

RS-232 Connectors and Pins

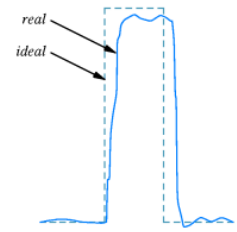
- RS-232 uses a 25 pin connector (extra pins for control functions)
- Computer transmits on pin 2 and receives on 3. Opposite on a modem

A 3 Wire RS-232 Connection



Limitations of Real Hardware

- Hardware cannot instantly change voltage and so imperfect signals must be detectable
- RS-232 specifies how much tolerance there should be



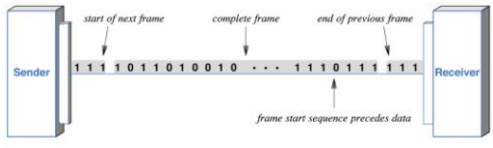
Synchronous Communication

- Synchronous mechanism transmits bits of data continually
  - No idle time between bits
- Advantage:
  - Sender and receiver synchronised at all time
    - Less synchronisation overhead compared with e.g. RS-232
    - Because no start and stop bits!

Synchronous Transmission – Bytes, Blocks and Frames

- If synchronous mechanism must send bits continually – what happens if no data to send?
  - Framing
    - Interface added to synchronous mechanism
    - Accepts and delivers a block of bytes called a frame
    - Frame starts with special sequence of bits
    - Common to include a special *idle sequence* between frames

Synchronous Transmission - Framing



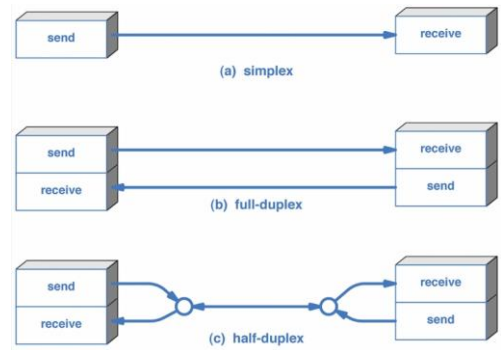
From Comer, 2009

Isochronous Transmission

- Designed to provide a steady bit flow for multimedia applications
  - Voice and video
- Enables network *jitter* to be managed
- With an isochronous network, data are accepted and sent at a fixed rate, R
  - Sender and receiver want to see a continuous stream of data without delays
  - Usually an underlying synchronous mechanism operating at slightly more than R bits per second

Simplex, Half-Duplex and Full-Duplex Transmission

- Simplex
  - Can only transfer data in a single direction
    - E.g. Single optical fibre
- Half-duplex
  - Data can transfer in both directions, but only one direction at a time
    - Shared transmission medium
    - Analogous to "walkie-talkies"
    - Additional mechanism needed at each end to coordinate transmission
- Full-Duplex
  - Data can transfer in both directions simultaneously
    - Typically consists of two simplex mechanisms
    - E.g. Pair of optical fibres, running in parallel



From Comer, 2009

Summary

- Transmission modes
  - Parallel, serial
- Transmission order and timing
- Synchronous, asynchronous and isochronous transmission
- RS-232 – an asynchronous transmission standard
- Simplex, half-duplex and full- duplex transmission
- Reading:
  - Chapter 9, Computer Networks and Internets, Comer, 5th Edition, 2009